Mutual Effect of Quantum Dots and Rare Earth Ions in glass Matrix

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Abstract

Both rare earth doped glass and ceramics, and quantum dots (QDs) in glass matrix have attracted much interests for their promising potential applications for optical and photonics devices, solar cells and others. In general, rare earth ions can be the nucleation agent of crystallization for oxide glass, oxy-fluoride glass and others, while the crystallization can improve the luminescence performance by aggregation and local environment change of rare earth ions. However, the function of rare earth ions on the chalcogenide based QDs was not clear yet. The interactions between rare earth ions and QDs for the luminescence were rarely investigated. In this research, the mutual effects of rare earth ions and QDs in silicate glass matrix was studied. Nd3+, Er3+ single doped silicate glass specimens with additional CdO and ZnSe, for CdSe QDs formation, were prepared by conventional melt-quenching method. The CdSe QDs with different diameters was fabricated by the subsequent heat treatment under different temperatures and durations. The absorption and photoluminescence peaks showed red shift because of increasing CdSe QDs diameter. In fact, the glass with Nd3+ or Er3+ ions presented absorptions and photoluminescence peaks with longer wavelength, accordingly lager CdSe QDs. X-Ray Diffraction, Raman spectra, Transmission Electron Microscope (TEM) also confirmed that the formation of CdSe QDs favored by the rare earth ions. Moreover, the infrared luminescence from Nd3+, Er3+ ions were enhanced by the formation of CdSe QDs. The Energy dispersive X-Ray Spectroscopy (EDS) and Electron Energy Loss Spectroscopy (EELS) proved the aggregation of rare earth ions into CdSe QDs, for low phonon energy surroundings, which enhanced the luminescence from rare earth ions.

Keywords: Photoluminescence, Semiconductor Nanocrystals, Local Environment, Nucleation Agent

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